REMARKS

Claim Rejections - 35 U.S.C. § 112

The Examiner has rejected claims 24-32 under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention. Applicant has amended claim 24, and canceled claims 30 and 32 to more particularly point out and distinctly claim the subject matter which Applicant regards as the invention.

Claim Rejections – 35 U.S.C. § 102/103

Claims 1-7, 14-29 and 31

The Examiner has rejected claims 1-7 under 35 U.S.C. 102(e) as being clearly anticipated by Gealy et al. (US Patent 6,082,375). The Examiner has rejected claims 14-16, 18 and 21-23 under 35 U.S.C. 102(b) as being clearly anticipated by Gealy et al. (US Patent 6,082,375). The Examiner has rejected claims 24-31 under 35 U.S.C. 103(a) as being unpatentable over Gealy et al. (US Patent 6,082,375) in view of Hasegawa (US Patent 5,677,015). The Examiner has rejected claim 32 under 35 U.S.C. 103(a) as being unpatentable over Gealy '375 and Hasegawa '015 as applied to claim 24 above, and further in view of Nishiki et al. (US Patent 5,989,782). The Examiner has rejected claims 13 and 20 under 35 U.S.C. 103(a) as being unpatentable over Gealy '375, as applied to claims 8 and 14 above, and further in view of Toshio (JP 04092423). The Examiner has rejected claims 17 and 19 under 35 U.S.C. 103(a) as

being unpatentable over Gealy '375, as applied to claim 14 above, and further in view of Hasegawa '015.

It is Applicant's understanding that the cited references fail to teach or render obvious Applicant's invention as claimed in claims 1-7, 14-29 and 31. Applicant claims in claims 1-7, 14-29 and 31 a method of forming dielectric layer of a semiconductor device. According to Applicant's claimed invention, a dielectric film is deposited over a substrate. The dielectric film is then exposed to remotely generated active atomic species, such as reactive oxygen atoms or reactive nitrogen atoms. The highly energized atomic species readily react with the dielectric film to fill vacancies in the lattice which left unfilled can lead to high leakage currents and poor device performance. Applicant does not understand the cited references to teach annealing a dielectric film with highly energized electrically neutral reactive species in order to improve the electrical characteristics of a dielectric film of a semiconductor device.

The Examiner cites Gealy as disclosing annealing a dielectric layer with remotely generated active atomic species. It is Applicant's understanding that Gealy does not teach a method of annealing a dielectric layer used in active devices. It is Applicant's understanding that Gealy describes a method of cleaning or removing build-up of a deposited dielectric from internal components of a reaction chamber. That is, Gealy teaches that after subsequent deposition of a deposited material, such as tantalum pentaoxide, the deposited material begins to build-up on internal surface of the reactor, such as platen 12. Gealy describes a method of how to remove this build-up from the internal chamber components. According to Gealy cleaning process, the deposited material is first treated with atomic oxygen. Gealy teaches that the treatment effectively increase the porosity in the deposited film, which enables the deposited oxide to be subsequently etched away with for example HF at a faster etch rate (Col. 3, lines 42-45). Thus, Gealy describes to treat oxide films with

oxygen atoms in order to make the subsequent etching of oxide film easier. Gealy does not teach or suggest to anneal a dielectric layer of a semiconductor device with active atomic species in order to fill vacancies in the lattice to reduce the leakage current and improve dielectric performance. Gealy simply teaches a method on how to clean a deposition chamber of unwanted deposits on chamber components.

It is to be appreciated that Gealy specifically states that during the cleaning of the internal chamber surfaces that substrates are preferably not (or typically not) included within the reactor (Col. 3, lines 27-30; and Col. 4, lines 38-41). As such, dielectric films formed on substrates in Gealy's process are not subject to an atomic oxygen treatment, because Gealy teaches substrates are not present in the chamber during the cleaning process (i.e., the atomic oxygen treatment and etch). If, for argument sake, the substrates do remain in the chamber during the cleaning of internal chamber surfaces, the clean (oxygen treatment and etching) would not only remove the deposited and treated oxide from the internal chamber surfaces, but also from the substrate surfaces. Removing the treated oxide films from the substrate would preclude their subsequent use in semiconductor devices.

As such, for the above mentioned reasons it is Applicant's understanding that the cited references clearly fail to teach or render obvious Applicant's invention as claimed in claims 1-7, 14-29 and 31. Applicant therefore respectfully requests the removal of the 35 U.S.C. 102 and 103 rejections and seeks and early allowance of these claims.

Claims 8-13

The Examiner has rejected claims 8-13 under 35 U.S.C. 102(b) as being clearly anticipated by Gealy et al. (US Patent 6,082,375).

With respect to claims 8-13, Applicant claims an embodiment of the present invention where remotely generated active atomic species are provided into the deposition chamber while the dielectric film is being deposited by chemical vapor deposition. In this way, the dielectric film is annealed as it is deposited thereby eliminating the need for a separate subsequent anneal step, if desired. Applicant does not understand Gealy to teach providing active atomic species into a chamber while depositing a dielectric layer as claimed by Applicant. As such, for the above mentioned reasons it is Applicant's understanding that Gealy fails to teach Applicant's invention as claimed.

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS

1. (Amended) A method of [annealing] forming a dielectric layer of a device, said method comprising [the steps of]:

forming a dielectric layer on a substrate;

generating ionized atoms in a first chamber;

flowing said ionized atoms through a conduit coupling said first chamber to a second chamber, wherein said ionized atoms become electrically neutral active atomic species before reaching said second chamber; [and]

exposing said dielectric layer to said active atomic species in said second chamber; and[.]

forming an electrode above said active atomic species exposed dielectric layer.

2. (Unchanged) The method of claim 1 wherein said active atomic species comprises reactive oxygen atoms.

3. (Unchanged) The method of claim 1 wherein said active atomic species comprises reactive nitrogen atoms.

4. (Unchanged) The method of claim 1 wherein said dielectric layer comprises a metal-oxide.

5. (Unchanged) The method of claim 1 wherein said dielectric layer comprises a transition metal dielectric.

6. (Unchanged) The method of claim 5 wherein said dielectric layer comprises tantalum pentaoxide (Ta_2O_5).

7. (Unchanged) The method of claim 1 wherein said dielectric layer is exposed to said active atomic species while being heated to a temperature of less than 400°C.

8. (Unchanged) A method of forming a dielectric layer comprising:

generating a plasma comprising ionized atoms in a first chamber;

flowing said ionized atoms through a conduit coupling said first chamber to a second chamber, wherein said ionized atoms become electrically neutral active atomic species before reaching said second chamber; and

depositing a dielectric layer onto a substrate by chemical vapor deposition in said second chamber and while depositing said dielectric layer, providing said active atomic species into said second chamber.

9. (Unchanged) The method of claim 8 wherein said active atomic species comprises reactive oxygen atoms.

10. (Unchanged) The method of claim 8 wherein said dielectric layer a metal oxide dielectric.

11. (Unchanged) The method of claim 8 wherein said dielectric layer comprises a transition metal dielectric.

12. (Unchanged) The method of claim 11 wherein said dielectric layer comprises tantalum pentaoxide (Ta_2O_5).

13. (Unchanged) The method of claim 8 wherein said dielectric layer comprises a silicon-oxide.

14. (Amended) A method of annealing a deposited oxide <u>of a device</u>, said method comprising [the steps of]:

locating a substrate in a first chamber, said substrate having a deposited oxide formed thereon;

generating a plasma comprising ionized oxygen atoms in a second chamber;

flowing said ionized oxygen atoms from said second chamber into said first chamber through a conduit wherein said ionized oxygen atoms become electrically neutral reactive oxygen atoms while flowing from said second chamber to said first chamber; [and]

exposing said deposited oxide to said reactive oxygen atoms<u>; and</u>[.]

<u>forming an electrode above said active atomic species exposed deposited oxide layer.</u>

15. (Unchanged) The method of claim 14 wherein said deposited oxide is exposed to said reactive oxygen atoms while heating said substrate to at a temperature of less than 400°C.

16. (Unchanged) The method of claim 14 wherein said second chamber is a microwave applicator cavity of a remote plasma generator.

17. (Unchanged) The method of claim 14 wherein said reactive oxygen atoms are formed by generating a plasma from O_2 molecules.

18. (Unchanged) The method of claim 14 wherein said reactive oxygen atoms are formed by generating a plasma from N_2O molecules.

19. (Unchanged) The method of claim 14 wherein said reactive oxygen atoms are formed by generating a plasma from O_2 molecules utilizing microwaves.

20. (Unchanged) The method of claim 14 wherein said deposited oxide is a silicon-oxide.

21. (Unchanged) The method of claim 14 wherein said deposited oxide is a metal-oxide.

22. (Unchanged) The method of claim 21 wherein said deposited metal oxide is a transition metal oxide.

23. (Unchanged) The method of claim 22 wherein said transition metal-oxide is tantalum pentaoxide (Ta_2O_5).

24. (Amended) A method of forming a capacitor, said method comprising [the steps of]:

forming a bottom electrode;

depositing a transition metal dielectric on said bottom electrode in a deposition chamber;

generating a plasma comprising ionized oxygen atoms by forming said plasma from an oxygen containing gas in a microwave applicator cavity [in] of a remote plasma [generation chamber] generator;

flowing said ionized oxygen atoms through a conduit coupling said [first chamber to a second chamber] microwave applicator cavity and said deposition chamber, wherein said ionized oxygen atoms become electrically neutral reactive oxygen atoms before reaching said [second] deposition chamber; [and]

annealing said transition metal dielectric in said [second] deposition chamber by exposing said transition metal dielectric to said reactive oxygen atoms; and

forming a top electrode above said reactive oxygen atom exposed transition metal dielectric.

25. (Unchanged) The method of claim 24 wherein said transition metal dielectric is tantalum pentaoxide (Ta_2O_5) deposited by chemical vapor deposition utilizing a source gas comprising TAETO.

26. (Unchanged) The method of claim 24 wherein said transition metal dielectric is tantalum pentaoxide (Ta_2O_5) formed by chemical vapor deposition utilizing a source gas comprising TAT-DMAE.

27. (Unchanged) The method of claim 25 wherein said tantalum pentaoxide dielectric layer is formed utilizing a source gas comprising O_2.

28. (Unchanged) The method of claim 24 wherein said transition metal dielectric layer is deposited at a temperature between 300-500°C.

29. (Unchanged) The method of claim 24 wherein said transition metal dielectric is formed with a source gas comprising N_2O.

30. Canceled

31. (Unchanged) The method of claim 24 wherein said transition metal dielectric film is annealed at a temperature less than 400°C.

32. Canceled